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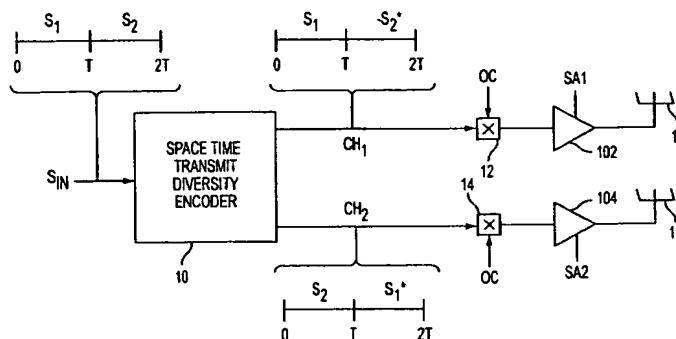
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(54) Title: CLOSED LOOP FEEDBACK SYSTEM FOR IMPROVED DOWN LINK PERFORMANCE



(57) Abstract: A method includes receiving at least two space-time coded signals from an antenna system associated with a first station, determining complex channel state information based on the received space-time coded signals, and sending the complex channel state information to the first station. In an alternative embodiment, a method includes transmitting at least two space-time coded signals in respective beams of a multi-beam antenna array, measuring a channel impulse response for each space-time coded signal at a second station, and sending an indicia of a selected set of least attenuated signals from the second station to the first station. The multi-beam antenna array is associated with a first station. The beams transmit a signature code embedded in each respective space-time coded signal, and the signature codes are orthogonal so that the second station can separate and measure the channel impulse response corresponding to each space-time coded signal. The space-time coded signals include the selected set of least attenuated signals and a remaining set of most attenuated signals. In an alternative embodiment, a method includes selecting at least two beams of plural beams formed by a multi-beam antenna array associated with a first station for transmission of a corresponding at least two space-time coded signals produced by a space-time encoder, determining a time delay associated with each of the at least two space-time coded signals as received in each respective beam, and setting into a variable delay line the time delay corresponding to each beam, each variable delay line being coupled between the multi-beam antenna array the space-time encoder.

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

## INTERNATIONAL SEARCH REPORT

 International Application No  
 PCT/IB 01/00967

 A. CLASSIFICATION OF SUBJECT MATTER  
 IPC 7 H04B7/06 H04B7/04

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

 Minimum documentation searched (classification system followed by classification symbols)  
 IPC 7 H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, INSPEC, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	R WICHMAN; A HOTTINEN: "Transmit Diversity in WCDMA System" INTERNATIONAL JOURNAL OF WIRELESS INFORMATION NETWORKS, vol. 6, no. 3, 1999, pages 171-180, XP001038053	1-17, 26-42
Y	page 174, paragraphs 3.2, 3.2.1 page 175, paragraph 3.3 page 176, paragraph 3.3.2 page 177, paragraph 3.4.1 --- -/-	18, 19, 43, 44

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

## \* Special categories of cited documents :

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
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- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \* & \* document member of the same patent family

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JONGREN ET AL: "Combining transmit antenna weights and orthogonal space-time block codes by utilizing side information" SIGNALS, SYSTEMS, AND COMPUTERS, 1999. CONFERENCE RECORD OF THE THIRTY-THIRD ASILOMAR CONFERENCE ON OCT. 24-27, 1999, PISCATAWAY, NJ, USA, IEEE, US, 24 October 1999 (1999-10-24), pages 1562-1566, XP010373893 ISBN: 0-7803-5700-0 page 1562, column 1, line 15 -page 1563, column 2, line 39 ---	1-17, 26-42
X	HEATH ET AL: "Multiple antenna arrays for transmitter diversity and space-time coding" COMMUNICATIONS, 1999. ICC '99. 1999 IEEE INTERNATIONAL CONFERENCE ON VANCOUVER, BC, CANADA 6-10 JUNE 1999, PISCATAWAY, NJ, USA, IEEE, US, 6 June 1999 (1999-06-06), pages 36-40, XP010333801 ISBN: 0-7803-5284-X page 36, column 1, line 1 -page 38, column 1, line 38 ---	1-17, 26-42
A	HOTTINEN ET AL: "Transmit diversity using filtered feedback weights in the FDD/WCDMA system" BROADBAND COMMUNICATIONS, 2000. PROCEEDINGS. 2000 INTERNATIONAL ZURICH SEMINAR ON ZURICH, SWITZERLAND 15-17 FEB. 2000, PISCATAWAY, NJ, USA, IEEE, US, 15 February 2000 (2000-02-15), pages 15-21, XP010376432 ISBN: 0-7803-5977-1 page 16, paragraph 2.2 ---	2-17, 27-42
Y	"3GPP RAN S1.14 V2.0.0, UTRA FDD; physical layer procedures" 3GPP RAN S1.14 V2.0.0, April 1999 (1999-04), pages 1-32, XP002184716 paragraph '08.1! - paragraph '08.4! ---	18,19, 43,44
X	EP 1 003 297 A (LUCENT TECHNOLOGIES INC) 24 May 2000 (2000-05-24) abstract paragraph '0009! - paragraph '0010! column 5, line 36-42 column 8, line 5-9; figures 5,6 --- -/--	20-25, 45-50

# INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 969 610 A (LUCENT TECHNOLOGIES INC) 5 January 2000 (2000-01-05) column 3, line 53-57 column 4, line 29-33 column 4, line 45-48 abstract figure 1A	20-25, 45-50
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X	US 5 613 219 A (VOGEL MARTIN DR-ING ET AL) 18 March 1997 (1997-03-18) column 4, line 49 - line 60	20-25, 45-50

# INTERNATIONAL SEARCH REPORT

national application No.  
PCT/IB 01/00967

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2. ☐ Claims Nos.:  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
  
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

As a result of the prior review under R. 40.2(e) PCT,  
no additional fees are to be refunded.

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
  
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
  
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
  
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☒ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1 - 17 and 26 - 42

determining complex channel state information based on the received space-time coded signals for feedback to a transmitter

2. Claims: 18, 19, 43 and 44

transmitting beams with an embedded signature code in a signal from a first station to a second station

sending an indicia of the selected set of least attenuated signals from the second station to the first station

3. Claims: 20 - 25 and 45 - 50

determining a time delay associated with a beam at a second station

setting into a variable delay line the time-delay of the encoder of a first station

## INTERNATIONAL SEARCH REPORT

 International Application No  
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